

REMARKS

Claims 1-28 are pending in this application. In the Office Action dated August 25, 2004, the Examiner took the following action: (1) objected to the specification for ascribing a meaning to "de-multiplexer" which is repugnant to the usual meaning of the term; (2) rejected claims 6 and 9 under 35 U.S.C. § 112, first paragraph, as failing to comply with the enablement requirement; (3) rejected claims 5 and 8 under 35 U.S.C. § 112, second paragraph, as failing to claim the disclosed invention; (4) rejected claims 1-3 under 35 U.S.C. § 102(b) as being anticipated by U.S. Patent No. 5,905,692 to Dolazza *et al.* and U.S. Patent No. 5,469,851 to Lipschutz; (5) rejected claims 1-3, 14-15 and 18-19 under 35 U.S.C. § 102(b) as being anticipated by U.S. Patent No. 5,622,177 to Breimesser *et al.*; (6) rejected claims 4-5 and 7-8 under 35 U.S.C. § 103(a) as being unpatentable over the patent to Breimesser *et al.* in view of U.S. Patent No. 4,170,766 to Pridham *et al.*; (7) rejected claims 6 and 9 under 35 U.S.C. § 103(a) as being unpatentable over the patent to Breimesser *et al.* in view of the patent to Pridham *et al.* as applied to claims 4 and 7, and in further view of U.S. Patent No. 6,102,863 to Pflugrath *et al.* and U.S. Published Patent Application No. 2002/0167971 to Van Stralen *et al.*; (8) rejected claims 10-11, 13 and 25-26 under 35 U.S.C. § 103(a) as being unpatentable over the patent to Breimesser *et al.* as applied to claim 1, and in further view of U.S. Patent No. 6,506,160 to Van Stralen *et al.*; (9) rejected claims 12 and 28 under 35 U.S.C. § 103(a) as being unpatentable over the patent to Breimesser *et al.* in view of the patent to Van Stralen *et al.* as applied to claim 11, and in further view of U.S. Patent No. 4,187,493 to Patterson; (10) rejected claim 16 under 35 U.S.C. § 103(a) as being unpatentable over the patent to Breimesser *et al.* as applied to claim 14, and in further view of U.S. Patent No. 4,519,250 to Sumino; (11) rejected claim 17 under 35 U.S.C. § 103(a) as being unpatentable over the patent to Breimesser *et al.* as applied to claim 14, and in further view of U.S. Patent No. 6,669,633 to Brodsky *et al.*; (12) rejected claims 20-22 and 24 under 35 U.S.C. § 103(a) as being unpatentable over the patent to Breimesser *et al.* as applied to claim 14, and in further view of the patent to Pridham *et al.*; and (13) rejected claim 23 under 35 U.S.C. § 103(a) as being unpatentable over the patent to Breimesser *et al.* as applied to claim 18, and in further view of the patent application to Van Stralen *et al.* (US2002).

The disclosed embodiments of the invention will now be discussed in comparison to the applied references. Of course, the discussion of the disclosed embodiments, and the discussion of the differences between the disclosed embodiments and the subject matter described in the applied references, do not define the scope or interpretation of any of the claims. Instead, such discussed differences merely help the Examiner appreciate important claim distinctions discussed thereafter.

The disclosed invention is directed to solving some of the same problem to which the invention described in the Breimesser *et al.* patent is directed. However, it does so in a different and more advantageous manner. Specifically, applicants' disclosed ultrasound imaging system multiplexes receive signals from a scanhead to provide a composite receive signal. Significantly, the composite receive signal requires a reduced number of conductors extending between the scanhead and an ultrasonic processor. At the ultrasonic processor, the composite receive signal is processed by a second multiplexer to recover the individual receive signals. However, it is also necessary to deal with the transmit signals. In the disclosed embodiment, multiplexers, which may be the same multiplexers through which the receive signals are coupled, are used to couple the transmit signals from the ultrasonic processor to the scanhead. More specifically, transmit signals generated by the ultrasonic processor are combined by a multiplexer to generate a composite transmit signal, which is coupled to the scanhead. A multiplexer at the scanhead recovers the individual transmit signals from the composite transmit signal.

The patent to Breimesser *et al.* uses multiplexers for coupling receive signals from a scanhead to ultrasonic processor, thereby reducing the number of conductors extending between the scanhead and the ultrasonic processor. However, Breimesser *et al.* failed to appreciate that the same or different multiplexers can be used to couple transmit signals from the ultrasonic processor to the scanhead. Instead, of teaching this approach, Breimesser *et al.* teach away from multiplexing transmit signals by disclosing a much more cumbersome and less cost-effective approach. Basically, Breimesser *et al.* provide transmit signals at the scanhead by moving much of the ultrasonic processor electronics required to generate the transmit signals from the processor to the scanhead. The effect of this approach is that a relatively large number of conductors are needed to couple the ultrasonic processor to the scanhead, and the scanhead is

relatively expensive and bulky. Yet it is highly desirable for the scanhead to be relatively inexpensive because multiple scanheads may be used with a single ultrasonic processor. Also, the scanheads are preferable as small and compact as possible within reason so that they can be manipulated easily.

The patent to Dolazza *et al.* in which the transducer elements in a scanhead are coupled to an ultrasonic processor through respective conductors. The ultrasonic processor includes a switching network that allows any of the transducer elements to be coupled to any of a plurality of processing channels in a beamformer. As a result, the signals from all of the transducer elements that are used to form single beam can be coupled through the same processing channel to provide a stream of delayed, time division multiplexed (TDM) samples. The stream of TDM samples are demultiplexed to form multiple streams of delay samples each of which are used to form a corresponding beam. The Dolazza *et al.* patent does not suggest multiplexing receive signals at the scanhead to form a composite signal, coupling the composite receive signal to the ultrasonic processor, and then demultiplexing the composite signal at the ultrasonic processor to recover the individual receive signals. Instead, all multiplexing and demultiplexing is done in the ultrasonic processor.

The claims are being amended to better distinguish over the prior art. Specifically, claim 1 now specifies that the claimed diagnostic ultrasonic imaging system includes a first multiplexer mounted in the scanhead having at least one first terminal and a plurality of second terminals coupled to respective ones of the transducer element terminals. The number of second terminals is substantially greater than the number of first terminals. The first multiplexer selectively couples each of the second terminals to a first terminal. As a result, the number of signal lines in a communications link coupling the scanhead to an ultrasonic processor can be significantly lower than the number of transducer elements in the scanhead. The ultrasonic processor includes a second multiplexer having a plurality of third terminals and at least one fourth terminal selectively coupled to a third terminal. The number of third terminals is substantially greater than the number of fourth terminals. The ultrasonic processor also includes a plurality of receivers coupled to the third terminals of the second multiplexer. As a result, the receive signals output from the transducer elements are coupled to the receivers through the first multiplexer, communications link and second multiplexer. The ultrasonic processor further

includes a plurality of transmitters coupled to the third terminals of the second multiplexer. As a result, transmit signals output from the transmitters are coupled to the transducer elements through the second multiplexer, communications link and first multiplexer. Thus, unlike the approach suggested in the prior art, both transmit signals and receive signals are multiplexed.

The remaining independent claim, claim 14, is directed to a method of coupling receive signals and transmit signals between respective transducer elements in an ultrasonic scanhead and an ultrasonic processor. The method includes combining the receive signals from a plurality of transducer elements into a composite receive signal at the scanhead. The composite receive signal is then coupled from the scanhead to the ultrasonic processor. At the ultrasonic processor, the composite receive signal is separated into a plurality of components each of which corresponds to a receive signal from a respective transducer element. A plurality of transmit signals are generated in the ultrasonic processor, and these transmit signals are combined in the ultrasonic processor into a composite transmit signal. The composite transmit signal is then coupled from the ultrasonic processor to the scanhead. The composite transmit signal is separated into a plurality of transmit signals at the scanhead, and these transmit signals are then coupled to respective transducer elements. Thus, both receive signals and transmit signals are multiplexed to allow the use of relatively few conductors extending between the scanhead and ultrasonic processor while allowing the scanhead to be relatively inexpensive and compact.

The remaining claims patentably distinguish over the cited references because of their dependency on patentable independent claims and because of the additional limitations added by those claims.

The Section 112 rejections are being obviated by amending the claims to eliminate the term “demultiplexing,” which the Examiner considers to be used improperly. With respect to the Examiner’s comments, applicant does not agree that the term “multiplexing” and “demultiplexing” is limited to parallel to serial conversion. Instead, the term “multiplexing” encompasses combining samples of different receive signals taken at different times into a single stream of samples and then routing the samples in that stream to different receivers, as shown in Figure 4 of the application. The remaining concerns of the Examiner are not entirely clear. If

there are any further questions or Section 112 issues, the Examiner is invited and requested to telephone the undersigned attorney so that the issues can be efficiently resolved.

All of the claims remaining in the application are now clearly allowable. Favorable consideration and a timely Notice of Allowance are earnestly solicited.

Respectfully submitted,

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